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(U.S.) National Eutrophication Survey, Corvallis, OR

Prepared for

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NATIONAL EUTROPHICATION SURVEY

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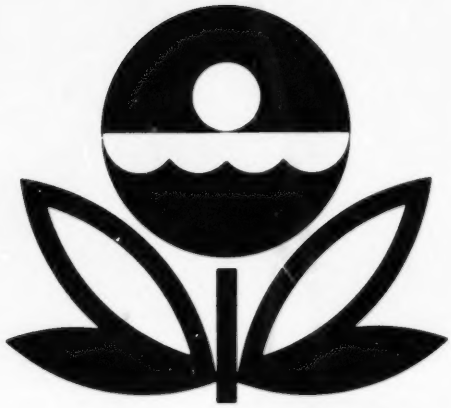

REPORT

ON

LOPEZ RESERVOIR

SAN LUIS OBISPO COUNTY

CALIFORNIA

EPA REGION IX

WORKING PAPER No. 750

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT
ON
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SAN LUIS OBISPO COUNTY
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WITH THE COOPERATION OF THE
CALIFORNIA STATE WATER RESOURCES CONTROL BOARD
AND THE
CALIFORNIA NATIONAL GUARD
JUNE, 1978

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentration (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the California State Water Resources Control Board and the nine Regional Water Quality Control Boards for professional involvement, to the California National Guard for conducting the tributary sampling phase of the Survey, and to those California wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Division of Planning and Research of the State Water Resources Control Board provided invaluable lake documentation and counsel during the Survey, coordinated the reviews of the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

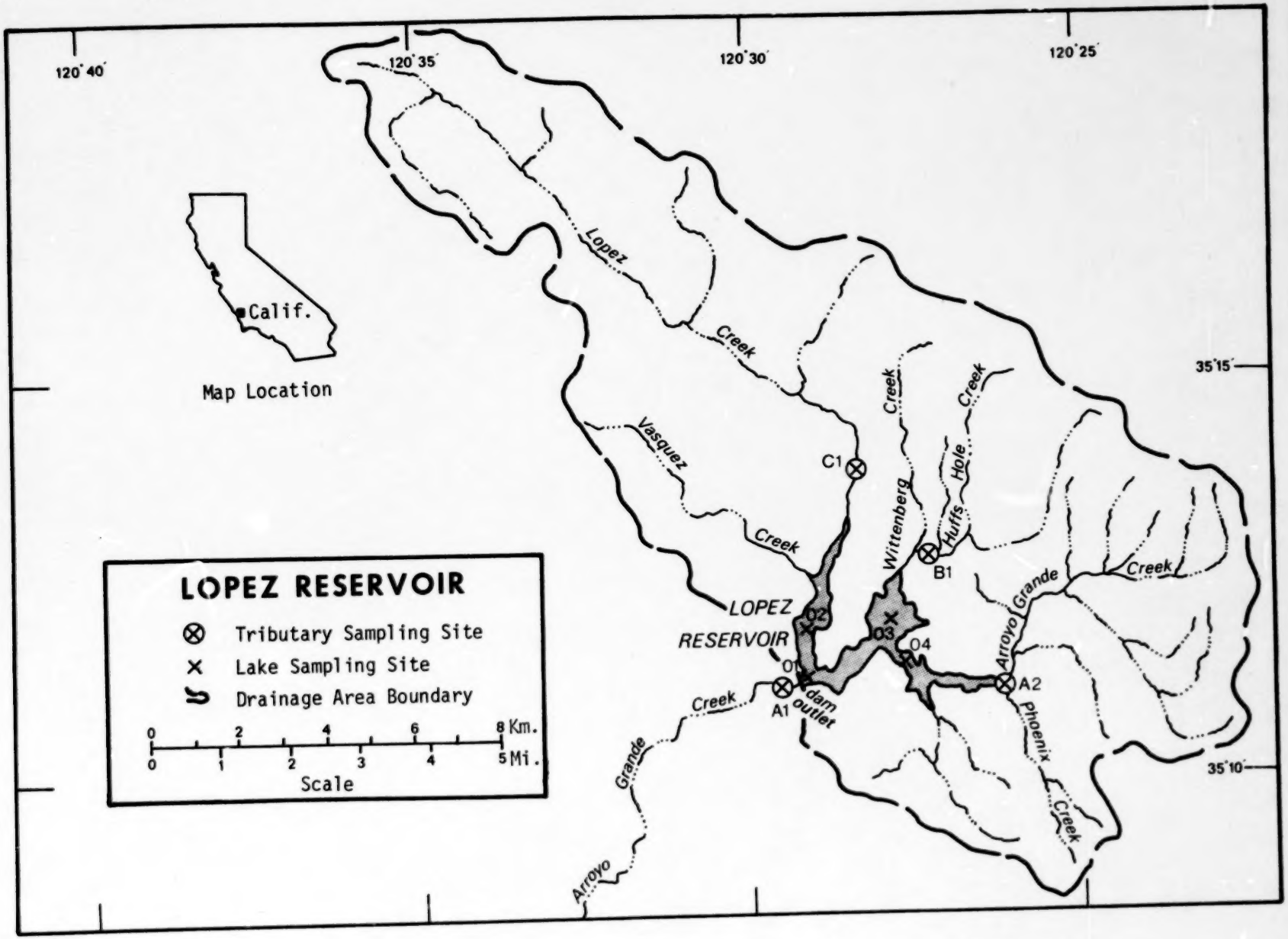
Major General Glen C. Ames, the Adjutant General of California, and Project Officer Second Lieutenant Terry L. Barrie, who directed the volunteer efforts of the California National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of California

Name	County
Amador	Amador
Boca	Nevada
Britton	Shasta
Casitas	Ventura
Crowley	Mono
Don Pedro	Tuolumne
Elsinore	Riverside
Fallen Leaf	El Dorado
Hennessey	Napa
Henshaw	San Diego
Iron Gate	Siskiyou
Lopez	San Luis Obispo
Mary	Mono
Mendocino	Mendocino
Nicasio	Marin
Lower Otay	San Diego
Pillsbury	Lake
Santa Margarita	San Luis Obispo
Shasta	Shasta
Shaver	Fresno
Silver	Mono
Tahoe	El Dorado, Placer, CA; Carson City, Douglas, Washoe, NV
Tulloch	Calaveras, Tuolumne
Lower Twin	Mono
Upper Twin	Mono


120°40'
120°35'
120°30'
120°25'
35°15'
35°10'
Calif.
Map Location
LOPEZ RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 2 4 6 8 Km.
0 1 2 3 4 5 Mi.
Scale
Lopez Creek
Vasquez Creek
Wittenberg Creek
Huffs Hole Creek
Arroyo Grande Creek
Phoenix Creek
Arroyo Grande Creek
C1
B1
A2
A1
dam outlet
LOPEZ RESERVOIR
O1
O2
O3
O4

LOPEZ RESERVOIR

STORET NO. 0614

I. CONCLUSIONS

A. Trophic Condition*:

Survey data indicate that Lopez Reservoir is eutrophic. It ranked nineteenth in overall trophic quality among the 24 California lakes and reservoirs sampled in 1975 when compared using a combination of six water quality parameters**. Twenty-two of the water bodies had less median total phosphorus, 23 had less median dissolved orthophosphorus, 17 had less median inorganic nitrogen, and 17 had less mean chlorophyll a. Six of the water bodies had greater mean Secchi disc transparency; however, Secchi disc depth was only measured once during the sampling year (06/25/75). Dissolved oxygen depletion with depth occurred at all four sampling stations in June and at stations 1 and 2 in November. Depression of hypolimnetic dissolved oxygen is reported to occur during summer stratification (Bailey, 1977).

Survey limnologists noted surface concentrations of algae in June and November and reported heavy growths of submerged aquatic weeds near station 1 in June.

Lopez Reservoir previously has been assessed as mesotrophic; but phytoplankton growths and fish kills have been noted as nuisance problems in this water body (Johns, 1975).

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* Trophic assment is based on levels of nutrients, dissolved oxygen, and chlorophyll a; phytoplankton kinds and numbers; and transparency (Allum et al., 1977).

** See Appendix A.

B. Rate-limiting Nutrient:

The algal assay results indicate Lopez Reservoir was nitrogen limited at the times the samples were collected (03/10/75 and 11/12/75). The reservoir data indicate nitrogen limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--No known wastewater treatment plants impacted the reservoir during the Survey sampling year. Septic tanks serving near-shore campgrounds were estimated to have contributed less than 0.1% of the total phosphorus input to Lopez Reservoir during the sampling year, but a shoreline survey would have to be conducted to determine the significance of such sources.

The present phosphorus loading of 1.12 g/m^2/year is four times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 13). Any reduction in the loading would require control of non-point source inputs.

2. Non-point sources--Non-point sources accounted for over 99.9% of the total phosphorus load during the sampling year. Arroyo Grande Creek contributed 25.6%, Lopez Creek contributed 21.2%, and the ungaged minor tributaries and immediate drainage contributed an estimated 51.6% of the total load.

Stream nutrient concentrations (see Appendix E) and relatively high non-point phosphorus export rates (see page 12) indicate diffuse inputs may be significant. In a previous

report, it is noted that much of the drainage basin is underlain by highly erodable, sedimentary geologic formations (Fuller et al., 1975). In addition, Survey geographers note that much of the land in the drainage is used for grazing and farming. An additional investigation is needed to determine if nutrient loads from such sources can be controlled by land-conservation practices.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 3.80 kilometers^2.
2. Mean depth: 16.6 meters.
3. Maximum depth: 50.6 meters.
4. Volume: 62.908 x 10^6 m^3.
5. Mean hydraulic retention time: 7.3 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Arroyo Grande Creek	35.2	0.044
Huffs Hole Creek	8.0	0.012
Lopez Creek	55.9	0.146
Minor tributaries & immediate drainage -	72.4	0.134
Totals	171.5	0.336**

2. Outlet - Aqueduct - 0.149
   Arroyo Grande Creek 175.3 0.125
   Totals 175.3*** 0.274***

C. Precipitation***:

1. Year of sampling: 62.1 centimeters.
2. Mean annual: 55.7 centimeters.

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† Table of metric equivalents--Appendix B.
†† Dendy, 1974.
* For limits of accuracy, see Working Paper No. 175, "... Survey Methods, 1973-1976".
** Inflows adjusted to equal outflow plus evaporation.
*** Includes area of reservoir; outflow for year of sampling provided by San Luis Obispo Cty. Flood Contr. & Water Cons. Distr.
**** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Lopez Reservoir was sampled three times in 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at four stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 38.1 meters at station 1, 22.6 meters at station 2, 17.1 meters at station 3, and 17.4 meters at station 4.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LOPEZ LAKE
STORET CODE 0614

PARAMETER	1ST SAMPLING (3/10/75) 4 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (6/25/75) 4 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (11/12/75) 4 SITES RANGE	MEAN	MEDIAN
TEMP (C)	9.7 - 12.3	11.1	11.4	9.4 - 20.3	15.8	18.5	10.1 - 15.4	13.9	14.4
DISS OXY (MG/L)	5.6 - 13.6	9.4	9.5	0.0 - 8.8	4.4	5.8	0.0 - 8.4	5.4	6.8
CNDCTVY (MCROMO)	477. - 497.	489.	490.	505. - 680.	597.	613.	455. - 520.	480.	484.
PH (STAND UNITS)	8.2 - 8.9	8.6	8.6	7.4 - 10.3	8.6	8.4	7.7 - 8.5	8.3	8.5
TOT ALK (MG/L)	305. - 475.	379.	375.	294. - 386.	328.	323.	280. - 374.	326.	333.
TOT P (MG/L)	0.351 - 0.484	0.394	0.380	0.310 - 0.808	0.505	0.420	0.274 - 0.900	0.451	0.365
ORTHO P (MG/L)	0.321 - 0.424	0.358	0.345	0.281 - 0.738	0.450	0.328	0.247 - 0.918	0.416	0.341
NO2+NO3 (MG/L)	0.020 - 0.190	0.045	0.020	0.020 - 0.140	0.025	0.020	0.020 - 0.060	0.038	0.040
AMMONIA (MG/L)	0.020 - 0.060	0.025	0.020	0.020 - 0.500	0.183	0.050	0.020 - 0.910	0.185	0.140
KJEL N (MG/L)	0.200 - 1.000	0.465	0.400	0.400 - 1.000	0.635	0.500	0.400 - 1.200	0.600	0.550
INORG N (MG/L)	0.040 - 0.220	0.070	0.040	0.040 - 0.520	0.208	0.070	0.040 - 0.930	0.223	0.180
TOTAL N (MG/L)	0.220 - 1.020	0.516	0.445	0.420 - 1.020	0.660	0.570	0.440 - 1.220	0.638	0.585
CHLRPYL A (UG/L)	13.5 - 21.6	16.1	14.7	1.9 - 4.7	3.1	2.9	5.4 - 7.8	6.7	6.9
SECCHI (METERS)	****** **********			2.4 - 4.6	3.3	2.7	****** **********		

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/10/75	1. Ceratium sp.	534
	2. Fragilaria sp.	140
	3. Stephanodiscus sp.	56
	4. Cryptomonas sp.	56
	5. Euglena sp.	28
	Total	814
06/25/75	1. Chroomonas (?) sp.	298
	2. Aphanizomenon sp.	216
	3. Schroederia sp.	162
	4. Fragilaria sp.	81
	5. Stephanodiscus sp.	54
	Other genera	55
	Total	866
11/12/75	1. Chroomonas (?) sp.	191
	2. Aphanizomenon sp.	127
	3. Cryptomonas sp.	127
	4. Ceratium sp.	64
	5. Oocystis sp.	42
	Other genera	21
	Total	572

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
03/10/75	1	14.0
	2	13.5
	3	15.4
	4	21.6
06/25/75	1	2.1
	2	4.7
	3	1.9
	4	3.7
11/12/75	1	7.3
	2	5.4
	3	7.8
	4	6.5

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. March sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.345	0.072	4.5
0.050 P	0.395	0.072	4.6
0.050 P + 1.0 N	0.395	1.072	37.8
1.0 N	0.345	1.072	37.7

b. November sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.360	0.255	12.9
0.050 P	0.410	0.255	12.5
0.050 P + 1.0 N	0.410	1.255	44.3
1.0 N	0.360	1.255	42.5

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of Lopez Reservoir was moderately high in March and high in November. Also, in both assays the lack of yield increase with the addition of phosphorus until nitrogen was also added indicates the reservoir was nitrogen limited at those times. Note that the addition of nitrogen alone resulted in yields significantly greater than those of the controls.

The reservoir data confirm the assay results. The mean inorganic nitrogen/orthophosphorus ratios were less than 1/1 at all sampling times, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the California National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). Sampling was begun in November, 1974, and was completed in November, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the California District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for the aqueduct were calculated using the mean nutrient concentrations measured at lake station 1 and the mean annual aqueduct flow.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Arroyo Grande, Huffs Hole, and Lopez creeks at stations A-2, B-1, and C-1 and the mean annual ZZ flow. Only one nutrient sample was collected from Huffs Hole Creek at station B-1, and nutrient loads for this tributary are included in the minor tributary loads.

No known wastewater treatment plants impacted the reservoir during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Arroyo Grande Creek	1,095	25.6
Lopez Creek	905	21.2
b. Minor tributaries & immediate drainage (non-point load) -	2,205	51.6
c. Known municipal STP's - None	-	-
d. Septic tanks* -	5	< 0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	65	1.5
Total	4,275	100.0

2. Outputs -

Reservoir outlet -	Arroyo Grande Creek	610
	Aqueduct	2,225
	Total	2,835

3. Net annual P accumulation -1,440 kg.

* Estimate based on four campgrounds; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Arroyo Grande Creek	1,970	16.4
Lopez Creek [a]	2,135	17.8
b. Minor tributaries & immediate drainage (non-point load) -	3,500	29.2
c. Known municipal STP's - None	-	-
d. Septic tanks* -	280	2.4
e. Known industrial - None	-	-
f. Direct precipitation** -	4,100	34.2
Total	11,985	100.0

2. Outputs -

Reservoir outlet -	Arroyo Grande Creek	2,845
	Aqueduct	5,020
	Total	7,865

3. Net annual N accumulation - 4,120 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Arroyo Grande Creek	31	56
Lopez Creek	16	38

* Estimate based on four campgrounds; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	1.12	0.38	3.2	1.1

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lopez Reservoir:

"Dangerous" (eutrophic loading)	0.30
"Permissible" (oligotrophic loading)	0.15

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0601	AMADOR RESERVOIR	0.040	0.390	408.667	22.383	14.600	0.020
0602	BOCA LAKE	0.012	0.040	372.833	1.700	6.800	0.003
0603	LAKE BRITTON	0.067	0.115	446.500	4.811	11.200	0.047
0604	CASITAS RESERVOIR	0.029	0.050	400.250	3.192	14.000	0.014
0605	CROWLEY LAKE	0.046	0.045	374.750	5.800	12.200	0.034
0606	DON PEDRO RESERVOIR	0.013	0.060	381.733	3.564	11.400	0.004
0607	LAKE ELSINORE	0.469	0.120	489.214	70.572	8.000	0.092
0608	FALLEN LEAF RESERVOIR	0.007	0.040	24.357	0.786	8.800	0.005
0609	LAKE HENNESSEY	0.027	0.060	416.000	4.525	15.000	0.012
0610	LAKE HENSHAW	0.138	0.070	461.000	26.783	9.800	0.073
0611	IRON GATE RESERVOIR	0.184	0.690	440.333	6.217	13.800	0.124
0614	LOPEZ LAKE	0.371	0.090	372.000	8.658	15.000	0.343
0615	LAKE MARY	0.010	0.040	296.000	2.550	10.600	0.002
0616	LAKE MENDOCINO	0.020	0.050	436.500	3.100	9.400	0.008
0617	NICASIO RESERVOIR	0.055	0.345	482.778	5.633	9.800	0.013
0618	LOWER OTAY RESERVOIR	0.058	0.180	447.250	15.933	15.000	0.013
0619	LAKE PILLSBURY	0.022	0.060	466.667	6.389	8.200	0.008
0620	SANTA MARGARITA LAKE	0.037	0.070	400.000	9.122	14.800	0.014
0621	SHASTA LAKE	0.021	0.060	381.542	4.087	9.000	0.015
0622	SHAVER	0.014	0.060	346.400	1.700	7.400	0.004
0623	SILVER LAKE	0.012	0.055	356.000	1.800	7.000	0.003
0624	TULLOCK RESERVOIR	0.025	0.060	433.000	13.878	7.400	0.009
0625	UPPER TWIN LAKES	0.015	0.040	300.200	3.340	7.400	0.004
0626	LOWER TWIN LAKES	0.014	0.040	248.000	2.900	11.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NU
0601	AMADOR RESERVOIR	35 (8)	4 (1)	43 (10)	9 (2)	17 (4)	26 (6)	134
0602	BOCA LAKE	89 (20)	98 (22)	70 (16)	91 (21)	100 (23)	91 (20)	539
0603	LAKE BRITTON	17 (4)	22 (5)	17 (4)	48 (11)	43 (10)	17 (4)	164
0604	CASITAS RESERVOIR	43 (10)	74 (17)	48 (11)	70 (16)	22 (5)	37 (8)	294
0605	CROWLEY LAKE	30 (7)	78 (18)	65 (15)	43 (10)	30 (7)	22 (5)	268
0606	DON PEDRO RESERVOIR	83 (19)	54 (11)	57 (13)	61 (14)	37 (8)	78 (17)	370
0607	LAKE ELSINORE	0 (0)	17 (4)	0 (0)	0 (0)	78 (18)	9 (2)	104
0608	FALLEN LEAF RESERVOIR	100 (23)	87 (19)	100 (23)	100 (23)	70 (16)	70 (16)	527
0609	LAKE HENNESSEY	48 (11)	54 (11)	39 (9)	52 (12)	4 (0)	52 (12)	249
0610	LAKE HENSHAW	13 (3)	33 (7)	13 (3)	4 (1)	54 (12)	13 (3)	130
0611	IRON GATE RESERVOIR	9 (2)	0 (0)	26 (6)	39 (9)	26 (6)	4 (1)	104
0614	LOPEZ LAKE	4 (1)	26 (6)	74 (17)	26 (6)	4 (0)	0 (0)	134
0615	LAKE MARY	96 (22)	87 (19)	91 (21)	83 (19)	48 (11)	100 (23)	505
0616	LAKE MENDOCINO	65 (15)	70 (16)	30 (7)	74 (17)	61 (14)	63 (14)	363
0617	NICASIO RESERVOIR	26 (6)	9 (2)	4 (1)	30 (7)	54 (12)	46 (10)	169
0618	LOWER OTAY RESERVOIR	22 (5)	13 (3)	22 (5)	13 (3)	4 (0)	46 (10)	120
0619	LAKE PILLSBURY	57 (13)	41 (9)	9 (2)	35 (8)	74 (17)	63 (14)	279
0620	SANTA MARGARITA LAKE	39 (9)	33 (7)	52 (12)	22 (5)	13 (3)	37 (8)	196
0621	SHASTA LAKE	61 (14)	54 (11)	61 (14)	57 (13)	65 (15)	30 (7)	328
0622	SHAVER	78 (18)	41 (9)	83 (19)	96 (22)	87 (19)	78 (17)	463
0623	SILVER LAKE	89 (20)	65 (15)	78 (18)	87 (20)	96 (22)	91 (20)	506
0624	TULLOCK RESERVOIR	52 (12)	54 (11)	35 (8)	17 (4)	87 (19)	57 (13)	302
0625	UPPER TWIN LAKES	70 (16)	98 (22)	87 (20)	65 (15)	87 (19)	78 (17)	485
0626	LOWER TWIN LAKES	74 (17)	87 (19)	96 (22)	78 (18)	37 (8)	91 (20)	463

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	0602	BOCA LAKE	539
2	0608	FALLEN LEAF RESERVOIR	527
3	0623	SILVER LAKE	506
4	0615	LAKE MARY	505
5	0625	UPPER TWIN LAKES	485
6	0626	LOWER TWIN LAKES	463
7	0622	SHAVER	463
8	0606	DON PEDRO RESERVOIR	370
9	0616	LAKE MENDOCINO	363
10	0621	SHASTA LAKE	328
11	0624	TULLOCK RESERVOIR	302
12	0604	CASITAS RESERVOIR	294
13	0619	LAKE PILLSBURY	279
14	0605	CROWLEY LAKE	268
15	0609	LAKE HENNESSEY	249
16	0620	SANTA MARGARITA LAKE	196
17	0617	NICASIO RESERVOIR	169
18	0603	LAKE BRITTON	164
19	0614	LOPEZ LAKE	134
20	0601	AMADOR RESERVOIR	134
21	0610	LAKE HENSHAW	130
22	0618	LOWER OTAY RESERVOIR	120
23	0607	LAKE ELSINORE	104
24	0611	IRON GATE RESERVOIR	104

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 - cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR CALIFORNIA 12/02/76

LAKE CODE 0614 LOPEZ RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 175.3

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
0614A1	175.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0614A2	35.2	0.159	0.178	0.150	0.105	0.040	0.037	0.031	0.023	0.017	0.023	0.045	0.071	0.073
061481	8.0	0.051	0.057	0.048	0.031	0.007	0.003	0.002	0.001	0.001	0.001	0.006	0.018	0.019
0614C1	55.9	0.538	0.595	0.510	0.340	0.147	0.119	0.108	0.065	0.057	0.068	0.142	0.218	0.240
0614ZZ	76.1	0.518	0.578	0.490	0.328	0.116	0.091	0.079	0.051	0.042	0.065	0.116	0.207	0.221

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 175.3
SUM OF SUB-DRAINAGE AREAS = 175.3

TOTAL FLOW IN = 6.69
TOTAL FLOW OUT = 0.0

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0614A1	11	74	0.0	17	0.0				
	12	74	0.0	8	0.0				
	1	75	0.0	18	0.0				
	2	75	0.0	2	0.0				
	3	75	0.0	1	0.0				
	5	75	0.0	3	0.0				
	7	75	0.0	28	0.0				
0614A2	11	74	0.040	17	0.037				
	12	74	0.051	8	0.042				
	1	75	0.037	4	0.040				
	2	75	0.068	2	0.311				
	3	75	0.057	1	0.054				
	5	75	0.042	3	0.048	31	0.042		
	7	75	0.023	28	0.017				
061481	11	74	0.001	17	0.001				
	12	74	0.003	8	0.002				
	1	75	0.004	4	0.004				
	2	75	0.045	2	0.566				
	3	75	0.034	1	0.010				
	5	75	0.009	3	0.010	31	0.007		
	7	75	0.003	28	0.002				
0614C1	11	74	0.119	17	0.119				
	12	74	0.159	8	0.110				
	1	75	0.136	4	0.167				
	2	75	0.467	2	5.380				
	3	75	0.473	1	0.136				
	5	75	0.150	3	0.178	31	0.119		
	7	75	0.068	28	0.062				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/09/24

061401
35 11 18.0 120 29 08.0 3
LOPEZ LAKE
06079 CALIFORNIA
140491

11EPALES 2111202
0129 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/10	15 50	0000	12.3	13.4		489	8.90	345	0.030	1.000	0.020K	0.323
	15 50	0005	12.0	13.6		489	8.90	335	0.020	0.900	0.020K	0.341
	15 50	0020	11.6	11.2		490	8.70	395	0.020	0.300	0.020K	0.340
	15 50	0035	10.5	9.0		486	8.50	360	0.020	0.200K	0.020K	0.353
	15 50	0050	10.1	8.2		484	8.40	330	0.020	0.200	0.020K	0.362
	15 50	0065	9.9	7.8		485	8.30	380	0.030	0.200K	0.050	0.376
	15 50	0080	9.8	6.4		487	8.20	445	0.030	0.200	0.120	0.398
	15 50	0100	9.7	6.4		488	8.20	375	0.030	0.200K	0.150	0.404
	15 50	0125	9.7	5.6		490	8.20	450	0.030	0.300	0.190	0.424
75/06/25	12 30	0000	19.3	7.4	180	620	7.40J	326	0.020	0.800	0.020K	0.310
	12 30	0005	18.8	8.4		670	10.30J	326	0.020K	0.500	0.020K	0.305
	12 30	0015	18.6	8.2		680	10.10J	296	0.030	0.500	0.020K	0.304
	12 30	0033	18.4	6.8		640	9.90J	316	0.030	0.500	0.020K	0.326
	12 30	0055	10.9	0.2		590	9.70J	350	0.080	0.500	0.140	0.484
	12 30	0080	9.7	0.0		590	9.40J	310	0.220	0.600	0.020K	0.536
	12 30	0105	9.4	0.0		590	9.30J	344	0.380	0.800	0.020K	0.554
	12 30	0124	9.4	0.0		610	9.00J	336	0.430	0.800	0.020	0.572
75/11/12	14 40	0000	14.6			494	8.55	338	0.120	0.600	0.040	0.335
	14 40	0005	14.5	7.0		490	8.50	334	0.140	0.600	0.040	0.339
	14 40	0015	14.4	7.0		491	8.50	284	0.140	0.500	0.040	0.344
	14 40	0035	14.4	6.4		491	8.50	304	0.140	0.600	0.040	0.359
	14 40	0060	14.4	0.0		456	7.90	296	0.910	0.800	0.020K	0.820
	14 40	0070	10.7	0.0		455	7.80	282	0.020K	1.200	0.020K	0.764
	14 40	0116	10.1	0.0		466	7.70	346	0.020K	0.600	0.020K	0.918

K VALUE KNOWN TO BE
LESS THAN INDICATED

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 76/09/24

061401
35 11 18.0 120 29 08.0 3
LOPEZ LAKE
06079 CALIFORNIA
140491

11EPALES 2111202
0129 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/10	15 50	0000	0.403	14.0	
	15 50	0005	0.424		
	15 50	0020	0.363		
	15 50	0035	0.369		
	15 50	0050	0.381		
	15 50	0065	0.391		
	15 50	0080	0.458		
	15 50	0100	0.462		
	15 50	0125	0.484		
75/06/25	12 30	0000	0.328	2.1	
	12 30	0005	0.325		
	12 30	0015	0.319		
	12 30	0033	0.330		
	12 30	0055	0.479		
	12 30	0080	0.582		
	12 30	0105	0.620		
	12 30	0124	0.630		
75/11/12	14 40	0000	0.359	7.3	
	14 40	0005	0.361		
	14 40	0015	0.365		
	14 40	0035	0.382		
	14 40	0060	0.900		
	14 40	0070	0.784		
	14 40	0116	0.856		

STORET RETRIEVAL DATE 76/09/24

061402
35 11 58.0 120 29 10.0 3
LOPEZ LAKE
06079 CALIFORNIA

140491

11EPALES 2111202
0078 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/11	09 15	0000	11.9	11.8		477	8.80	305	0.030	0.700	0.020K	0.321
	09 15	0005	11.7	10.2		490	8.75	385	0.020	0.400	0.020K	0.343
	09 15	0015	11.6	10.0		490	8.75	410	0.020	0.300	0.020K	0.343
	09 15	0030	11.3	9.8		489	8.60	475	0.020	0.200K	0.020K	0.347
	09 15	0045	10.3	7.6		484	8.30	405	0.020	0.300	0.020K	0.365
	09 15	0060	9.9	6.4		486	8.25	475	0.030	0.400	0.070	0.390
	09 15	0074	9.9	6.0		488	8.20	365	0.040	0.200	0.120	0.409
75/06/25	11 45	0000	19.5	8.4		620	8.00	298	0.030	0.500	0.020K	0.281
	11 45	0005	19.4	8.4		620	8.00	382	0.030	0.500	0.020K	0.288
	11 45	0015	19.0	8.6		615	8.00	386	0.020	0.600	0.030	0.295
	11 45	0030	17.6	4.8		600	8.00	318	0.020K	0.400	0.020K	0.326
	11 45	0050	11.6	0.0		520	7.80	296	0.280	0.700	0.020K	0.586
	11 45	0072	10.0	0.0		505	7.80	306	0.330	0.700	0.020K	0.578
75/11/12	15 00	0000	15.1	7.4		471	8.50	316	0.120	0.500	0.040	0.344
	15 00	0005	15.0	6.8		484	8.50	374	0.140	0.500	0.040	0.347
	15 00	0015	14.3	6.2		460	8.50	340	0.140	0.600	0.040	0.349
	15 00	0040	14.2	6.2		485	8.50	280	0.160	0.500	0.050	0.351
	15 00	0060	14.0	3.8		483	7.95	330	0.830	0.600	0.060	0.426
	15 00	0070	10.7	0.0		462	7.90	370	0.020K	1.000	0.020K	0.656

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/11	09 15	0000	0.351	13.5	
	09 15	0005	0.362		
	09 15	0015	0.362		
	09 15	0030	0.363		
	09 15	0045	0.381		
	09 15	0060	0.406		
	09 15	0074	0.484		
75/06/25	11 45	0000	0.310	4.7	
	11 45	0005	0.328		
	11 45	0015	0.330		
	11 45	0030	0.359		
	11 45	0050	0.632		
	11 45	0072	0.640		
75/11/12	15 00	0000	0.371	5.4	
	15 00	0005	0.373		
	15 00	0015	0.365		
	15 00	0040	0.376		
	15 00	0070	0.888		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

061403
35 11 58.0 120 27 47.0 3
LOPEZ LAKE
06079 CALIFORNIA

140491

11EPALES 2111202
0055 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/11	10 05	0000	12.2	12.4		494	8.90	325	0.020	0.800	0.020	0.338
	10 05	0005	12.2	12.0		495	8.80	365	0.020	0.700	0.020K	0.336
	10 05	0015	12.0	11.0		497	8.80	360	0.020	0.500	0.020K	0.341
	10 05	0030	11.4	9.2		494	8.65	380	0.020	0.500	0.020K	0.334
	10 05	0051	10.1	5.6		492	8.30	375	0.060	0.500	0.070	0.386
75/06/25	14 30	0000	19.8	8.4	96	625	8.55	342	0.020	0.500	0.020K	0.311
	14 30	0005	19.8	8.8		625	8.70	318	0.020K	0.500	0.020K	0.309
	14 30	0015	19.3	8.2		625	8.70	344	0.020K	0.500	0.020K	0.317
	14 30	0030	18.0	2.8		600	8.10	336	0.250	0.500	0.020K	0.570K
	14 30	0045	11.8	0.0		525	8.05	320	0.440	0.900	0.020K	0.738
	14 30	0056	10.6	0.4		515	8.25	374	0.490	0.900	0.020K	0.722
75/11/12	14 15	0000	14.5	8.4		497	8.50	336	0.120	0.600	0.020	0.321
	14 15	0005	14.5	7.0		471	8.50	316	0.120	0.500	0.050	0.327
	14 15	0015	14.3	6.6		485	8.50	282	0.140	0.400	0.050	0.318
	14 15	0030	14.2	6.8		475	8.55	372	0.100	0.500	0.040	0.312
	14 15	0046	13.6	6.8		484	8.50	338	0.110	0.700	0.050	0.296

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/11	10 05	0000	0.362	15.4	
	10 05	0005	0.369		
	10 05	0015	0.361		
	10 05	0030	0.371		
	10 05	0051	0.415		
75/06/25	14 30	0000	0.359	1.9	
	14 30	0005	0.357		
	14 30	0015	0.361		
	14 30	0030	0.510		
	14 30	0045	0.808		
	14 30	0056	0.778		
75/11/12	14 15	0000	0.350	7.8	
	14 15	0005	0.346		
	14 15	0015	0.337		
	14 15	0030	0.347		
	14 15	0046	0.396		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

061404
35 11 26.0 120 27 46.0 3
LOPEZ LAKE
06079 CALIFORNIA

140491

11EPALES 2111202
0049 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/11	10 45	0000	12.2	12.6		493	8.85	375	0.020	1.000	0.020K	0.338
	10 45	0005	12.0	12.0		493	8.90	375	0.020	0.800	0.020K	0.339
	10 45	0015	12.0	11.0		493	8.80	330	0.020K	0.600	0.020K	0.338
	10 45	0030	11.4	8.6		494	8.40	335	0.020K	0.400	0.020K	0.350
	10 45	0045	10.3	7.0		489	8.50	395	0.020	0.300	0.030	0.368
75/06/25	16 00	0000	20.3	8.4	108	635	8.80	356	0.060	0.500	0.020K	0.323
	16 00	0005	19.7	8.6		625	8.80	336	0.030	0.500	0.020K	0.325
	16 00	0015	19.2	7.6		620	8.80	318	0.040	0.500	0.020K	0.330
	16 00	0030	18.7	0.6		610	8.10	312	0.500	0.900	0.020K	0.700
	16 00	0046	11.5	0.0		525	8.10	298	0.490	1.000	0.020K	0.664
	16 00	0057	10.5	0.0		515	8.05	294	0.490	0.900	0.020K	0.640
75/11/12	14 00	0000	15.4	7.6		520	8.25	320	0.120	0.500	0.040	0.247
	14 00	0005	14.4	6.4		489	8.50	344	0.140	0.400	0.040	0.329
	14 00	0015	14.4	6.8		479	8.50	338	0.160	0.500	0.040	0.326
	14 00	0044	14.2	6.8		478	8.50	332	0.160	0.500	0.040	0.327

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/11	10 45	0000	0.395	21.6	
	10 45	0005	0.379		
	10 45	0015	0.378		
	10 45	0030	0.368		
	10 45	0045	0.395		
75/06/25	16 00	0000	0.688	3.7	
	16 00	0005	0.360		
	16 00	0015	0.349		
	16 00	0030	0.782		
	16 00	0046	0.790		
	16 00	0057	0.774		
75/11/12	14 00	0000	0.274	6.5	
	14 00	0005	0.346		
	14 00	0015	0.350		
	14 00	0044	0.338		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/09/24

0614A1
35 11 10.0 120 29 24.0 4
ARROYO GRANDE CREEK
06 7.5 TAR SPRG RID
O/LOPEZ RESERVOIR 140491
BNK BELO LOPEZ DAM 300 FT S OF LOPEZ DR
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/17	11 30		0.008	1.300	0.025	0.075	0.075
74/12/08	09 35		0.024	0.700	0.032	0.086	0.100
75/01/18	15 00		0.015	2.300	0.024	0.080	0.100
75/09/07	11 55		0.050	0.700	0.085	0.300	0.345

STORET RETRIEVAL DATE 76/09/24

0614A2
35 11 03.0 120 26 11.0 4
ARROYO GRANDE CREEK
06 7.5 TAR SPRG RID
T/LOPEZ RESERVOIR 140491
BNK AT USGS GG STATION 11 MI E US 101
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/17	09	00	0.120	0.700	0.050	0.610	0.630
74/12/08	09	50	0.164	0.300	0.042	0.551	0.595
75/01/04	13	15	0.144	0.900	0.032	0.490	0.520
75/02/02	10	00	0.240	3.300	0.168	0.960	2.000
75/03/01	15	00	0.224	4.000	0.084	0.502	0.870
75/05/03	12	45	0.005	0.300	0.030	0.510	0.500
75/05/31	10	30	0.005	1.800	0.050		0.560
75/07/28	16	10	0.100	0.950	0.025	0.775	0.780
75/09/07	10	05	0.075	0.400	0.020	0.710	0.750
75/11/02	14	00	0.065	0.400	0.015	0.590	0.690

STORET RETRIEVAL DATE 76/09/24

061481
35 13 02.0 120 27 17.0 4
HUFFS HOLE CREEK
06 7.5 TAR SPRG RID
T/LOPEZ RESERVOIR 140491
LOPEZ CYN RD BRDG 14.2 MI NE OF US 101
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/05/31	10 45		0.050	0.550	0.060	0.575	0.580

STORET RETRIEVAL DATE 76/09/24

0614C1
35 13 48.0 120 28 22.0 4
LOPEZ CREEK
06 7.5 TAR SPRG RID
T/LOPEZ RESERVOIR 140491
BNK 50 FT E OF WATERS END RD
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/17	10	20	0.008	1.000	0.025	0.195	0.199
74/12/08	10	25	0.016	0.100K	0.011	0.196	0.205
75/01/04	14	00	0.024	0.300	0.024	0.190	0.190
75/02/02	10	50	0.320	0.300	0.024	0.175	0.180
75/03/01	15	30	0.016	0.700	0.032	0.184	0.190
75/05/03	13	15	0.010	0.050K	0.010	0.190	0.200
75/05/31	11	00	0.005	0.100	0.015	0.190	0.200
75/07/28	16	30	0.005	0.750	0.005	0.190	0.200
75/09/07	10	15	0.025	0.700	0.015	0.190	0.210
75/11/02	14	30	0.015	0.200	0.010	0.190	0.200

K VALUE KNOWN TO BE
LESS THAN INDICATED